BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

SUBJECT: WTR Dock Facilities for Future Launch Programs Case 103

DATE: December 9, 1968

FROM: G. W. Craft

ABSTRACT

In general, missions flown from ETR are constrained from polar and near-polar earth orbits. The Western Test Range launch facility at Point Arguello, California provides an ability to launch into highly inclined orbits but is currently constrained from handling very large boosters by its lack of waterway docking facilities. This memorandum reviews this logistics problem and the alternative solutions for vehicles in the proposed 100,000-pound payload (to low earth orbit) category and upward.

In most of the cases, with the notable exception of the 156-inch cluster vehicle, docking facilities are clearly required. The cost of such facilities, however, is well down in the noise of uncertainty with respect to the overall cost of the necessary new launch facilities for these vehicles. In the specific case of the 260-inch SRM boosted vehicle, a dockside receiving/launching facility could conceivably result in a lower overall launch facility cost than an equivalent inland facility where rail delivery of booster components might be feasible.

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MEMORANDUM FOR FILE

Introduction

During discussions with the author, members of OART have indicated a concern with the logistics problems which may be associated with launching very large rockets from Point Arguello over the Air Force's Western Test Range. In particular, the concern is that large and heavy solid rocket stages requiring transport by waterway cannot be landed at the launch area without massive expenditures on docking facilities.

The question of WTR logistics is of somewhat broader concern than might be implied from its origin with the OART solid rocket propulsion group. Under current launch rules, ETR launches are constrained to a sector 72°-108° obviating polar and near-polar orbits for DOD and NASA missions flown from that launch area without the severe penalty of a dogleg maneuver during the boost phase. Plane changes after the boost phase are even more penalizing in the useful payload that can finally be placed in highly inclined orbits.

This memorandum is intended to provide a brief resume of the logistics problems facing operations with large vehicles at WTR and the impact of these problems on concept selection relative to other considerations such as launch technique and total facility cost.

Point Arguello

The U. S. Naval Missile Facility at Point Arguello, is located adjacent to Vandenberg Air Force base on a relatively desolate point of the California Coast about one hundred and thirty miles northwest of Los Angeles. Vandenberg AFB is situated on a broad part of the narrow coastal plane on the north side of the Facility but the flat area between local mountains and the shoreline cliffs averages less than a quarter mile wide in much of the missile test area.

The launch complexes (Thor, Atlas, Titan I, Titan II, and Titan III) are located within a few hundred feet of the ocean as at Cape Kennedy.

The Pacific shoreline in this region is characterized by steep cliffs dropping abruptly from perhaps 50 to 75 feet to a very narrow rubble strewn beach. The rocky sea bottom drops from less than fifteen feet to deep water within three or four hundred yards. Seawater and air temperatures are decidedly chilly (50-65°F) but relatively constant year around although overnight temperatures inland may occasionally go below freezing. Tidal range is about four feet. Typical sea waves are probably less than three feet high. Storms at sea occasionally raise this level appreciably. Tropical disturbances are rare in the region and rainfall is low, well under one inch during most months. The area is known for hazy conditions with clearing during the middle of the day. Corrosion and similar problems from salt spray, however, appear to be much less than is typical in the Cape Kennedy area.

Landside access to the launch area by standard highway seems to be adequate and the main line of the Southern Pacific Railway between Los Angeles and San Francisco runs directly through the launch area. Vandenberg AFB has runways capable of supporting operations of any Air Force or Aero Space Lines air cargo delivery systems. Existing dock facilities in the region are capable of handling only small Coast Guard type utility boats.

Vehicle Logistics

Until now vehicles launched at Point Arguello have not presented any significant logistics problems. Agena, Centaur, Atlas, Titan II, and Titan III stages are all deliverable by air. The 120-inch diameter, ten foot-long segments of Titan III strap-on rockets are deliverable by truck or by railway without notable difficulty.

156" SRM (Solid Rocket Motor) Cluster Launch Vehicle

This vehicle has been studied for both AF and NASA for payloads in the 100,000-pounds-to-low-earth-orbit range. It is based on the largest diameter SRM segments that are deliverable by railroad. No major logistics problems are anticipated for this vehicle although local limitations on railway cargo width between the point of SRM segment manufacture and the launch area may require careful route selection and some expense for obstacle removal.

260" SRM

With a S-IVB stage, this 1800 ton monolithically cast solid rocket motor would have a payload to low earth orbit of about 100,000 pounds. Production casting facilities

for the SRM would most likely be located on the East Coast. The weight of the motor as cast makes long distance transport other than by barge infeasible. At Point Arguello, new dock facilities and a breakwater protected stilling basin would be required to handle the type of barge required. (A floating dry dock vessel has been recommended by Douglas for deep water transport of the 260" SRM.)

A possible alternative, air transport, has been considered under the assumption that a casting plant could be built at or near the launch site. However, although the 260" SRM motor case is the same diameter as the S-IVB, it weighs 200,000-227,000 pounds depending on whether the insulation and liner have been installed. The Aero Space Line's Pregnant Guppy has a payload capacity of only 33,000 lb. The Lockheed C-5A will have adequate payload capacity, 220,000 pounds, or in its commercial version, the 500-114M, 281,100 pounds. It is also long enough (120 ft. between ramp hinges--the 260" motor case would be about 114 feet long) but its cargo space is only 19 feet wide by 13.5 feet high.

It appears that only by making a jointed case of, say eight sections, transportable by Pregnant Guppy, and using a cast-on-site strategy could waterway transport of the 260" SRM to WTR be avoided. The cost of a mixing/casting facility for the monolithic rocket has been roughly estimated in the neighborhood of fifteen million dollars. But the potential for savings in handling and launch facility costs obtainable by casting the motor right at its launch site--possibly in a military style silo*--have not been factored into this estimate.

Hypergol Fueled Vehicles

The two, three, and four stage versions of 100,000 pound payload hypergol fueled launch vehicles, outlined in current studies by TRW for NASA, all have stages of much larger diameter than is presently transportable by air, rail or truck. Water delivery seems to be mandatory.

Saturn IB and Saturn V

The Saturn IB first stage is normally assembled by Chrysler at Michoud, tested at MTF, and delivered by water to Cape Kennedy. To duplicate the assembly and test facilities at WTR would be excessive for the few missions that

*A Self-Eject Silo Launch concept was thought highly of, even for NASA programs, in the most recent study of launch concepts for big solids by the McDonnell Douglas Corporation.

now seem likely to require that sites' launch azimuth flexibility. The S-IB is both too heavy and too long for the Pregnant Guppy. It would have to be delivered by water.

The Saturn V launch vehicle has two stages, the S-IC and S-II, that are too heavy and too large (33 ft. diameter) for air transport. Waterway delivery is the only alternative.

Docking Facilities for WTR

The outside dimensions of vessels likely to be used for open sea transportation of large stages to WTR are typified by those of the mothballed U. S. Navy ARD recommended by Douglas for the 260" SRM*. This vessel is an unpowered barge 488 feet long and 81 feet wide having a loaded draft of 8.4 feet. Docking facilities for such a vessel would have to assure a channel and turning basin depth in wave protected water of about ten feet. At WTR this could likely be provided by a moderate amount of channel blasting and a rubble jetty perhaps two thousand feet long. The dock design would depend upon the method chosen for unloading the barge and transporting the vehicle to the top of the cliffs. For light weight booster stages, a ramp and rubber tired transporter system providing a high degree of flexibility together with low cost would be the most likely choice. For the 260" SRM, advantage should be taken of any method which would avoid the need for a transporter and minimize the cost of lifting equipment. A system similar to the Dock Launch Concept** would use the dock itself as the launch site. In this case, the dock would be enclosed and capable of varying the water level within it by about forty-four feet. With a floatable flame deflector, the dock would ultimately serve as a flame duct during the launch itself.

The Self-Eject Silo Launch concept could also be built in conjunction with the receiving dock. Here, however, a separate lifting gantry crane would probably be used to unload the delivery barge, raise and transport the SRM through very short distances and lower it into the launching silo. Alternatively, a prefabricated silo could be assembled about the stage after it is rotated to the vertical***.

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*DAC 58078 December 28, 1967 "Launch Facilities and Operations for Large Solid Motors Study," Contract NAS 10-4802

**Bellcomm Technical Reports TR 66-330-2 and TR 66-330-3. The Bellcomm concept, however, assumed a small barge for operating on the intracoastal waterway. The concept would have to be modified if a larger, sea-going barge became necessary.

***A method also described in the DAC Study (See Volume III)

In all of these concepts, the cliffs fronting Point Arguello would provide an excellent bases of foundations for the unloading dock and for the Service Structure and gantry rail beams and launch stand.

Costing and the Larger Picture

Any of the large vehicles that are being discussed here will require the construction of entirely new launch facilities. The probable cost of minimal WTR facilities, capable of one or two polar orbit launches per year without major element redundancy, in the 100,000 pound payload class would be in the range: $60M to $100M. Minimal Saturn V facilities would cost between $150M and $250M.

The channel, breakwater, dock, and unloading facilities for Saturn V and other light weight stages would probably generate costs in the two-three million dollar range.

The cost of the same facilities for a heavy stage like the 260" SRM with transporting equipment for overland travel to a launch stand several hundred feet inland and lifting facilities at the launch stand would be increased by five to ten million dollars.

A docksite facility for the 260" SRM, whether it used a gantry crane or a hydraulic lifting system and whether it used a silo or a flame trench, would have the advantage of requiring a much smaller Service Structure and umbilical tower than a 156 inch cluster vehicle launched from an inland site. This factor alone would probably balance any additional costs that might be incurred in combining the dock, lifting system, and launch stand for the 260". Note also that the 156 inch cluster lends itself much less to the self-eject launch technique--and underground silo--than does the 260".

Finally, even if the 156 inch cluster vehicle were launched from a cliff-side facility, the difference in cost between it and the 260 inch SRM launch facility from differences in the stage delivery/receiving/installation systems would probably be in the cost of the jetty and basin and barge tieup facilities.

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